Joint UW-3TIER Project on Data Assimilation for Renewable Energy Forecasting

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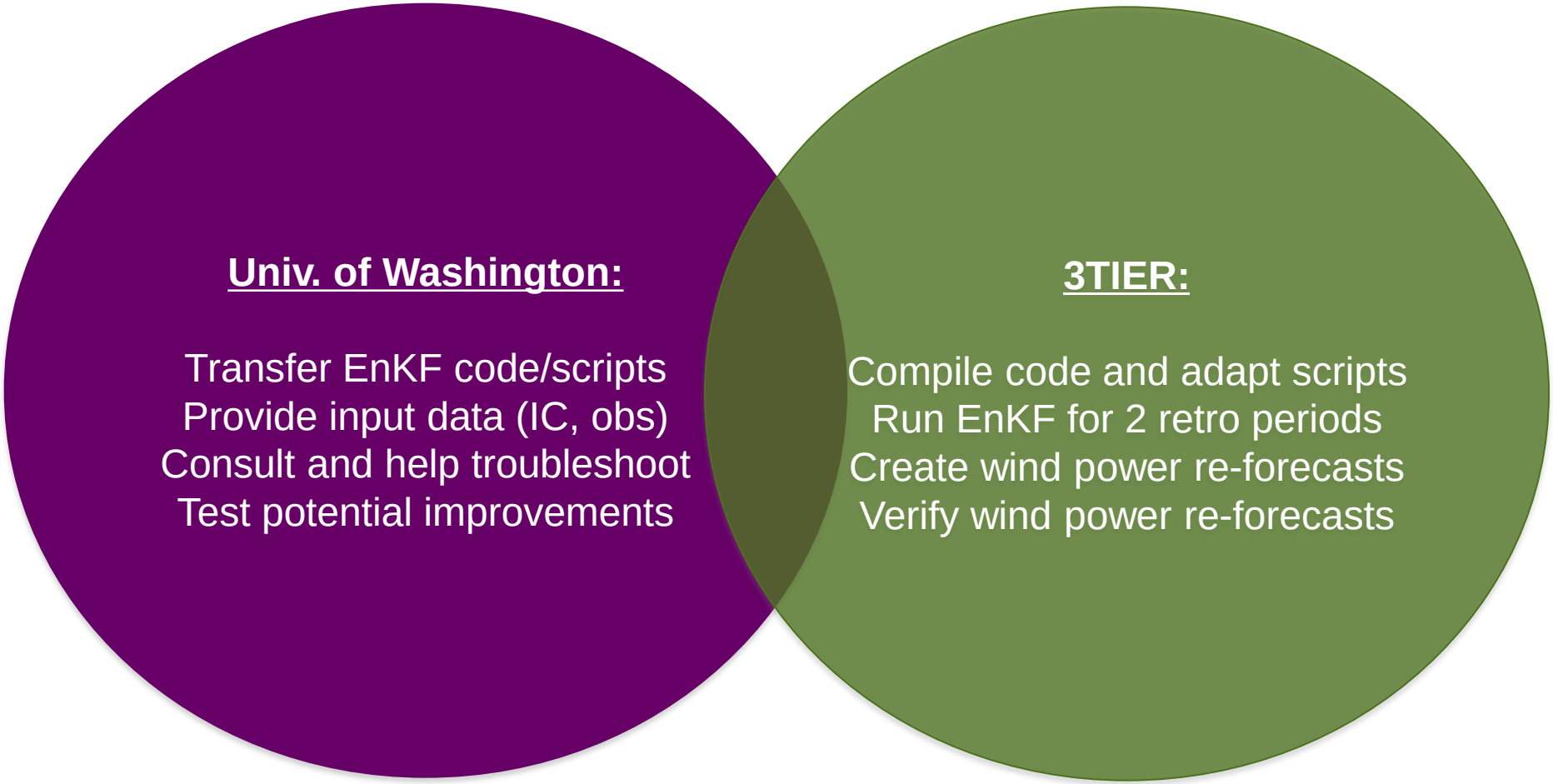
Background

- 3TIER does not currently use data assimilation in its own mesoscale modeling process. All WRF forecast runs are "cold-started" from interpolated GFS analyses 4 times/day.
  - Strong need for dramatic improvements in 0-6 hr forecasting of wind power
  - Strong need for more frequent updates and better use of local observations

- In June 2011, 3TIER and the University of Washington entered an arrangement for the joint evaluation and improvement of a state-of-the-art ensemble-based NWP data assimilation and forecast system.
  - UW interested in seeing its technologies adopted to solve industry problems

- Project Goal: Test UW WRF-EnKF system's potential for industrial application in renewable energy forecasting.

Roles



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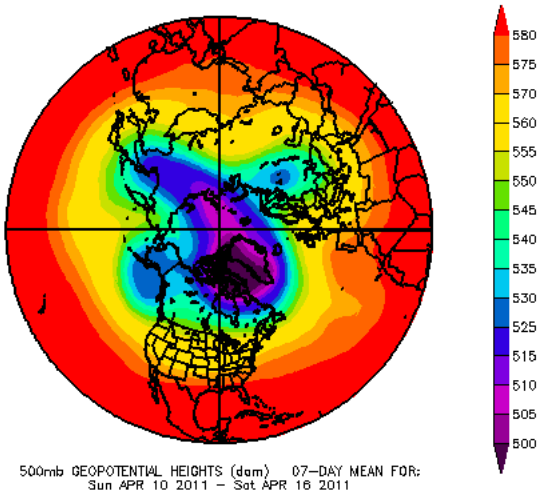
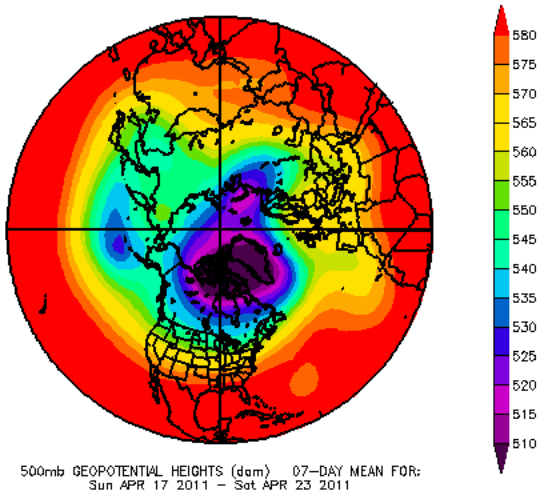
UW WRF-EnKF System Specs

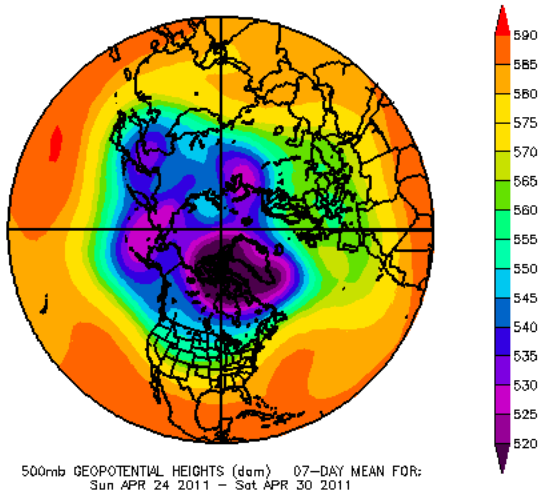
- Uses WRF V3.0.1 and DART post-Jamaica release
- 36 km outer grid over Pacific NW, 4 km inner nest over WA/OR
- 64-member ensemble
- 3-hourly assimilation cycles (00, 03, 06, 09, 12, 15, 18, 21 UTC)
- Regional observation data with quality control applied:
  - Radiosonde: U, V, T, RH
  - Aircraft (ACARS): U, V, T
  - Cloud-track winds: U, V
  - Buoy Stations (Fixed and Drift): P
  - Land Stations (ASOS and Mesonet): ALT, U, V, T (if model/ob elev diff < 300m)

Retrospective Test Period

- April 10-30, 2011
  - Synoptically active period of moderate-strong W and NW flow
  - Notable for significant timing and intensity errors in existing NWP models, including WRF-GFS
  - Period of above average wind power generation punctuated by large swings (“ramps”)







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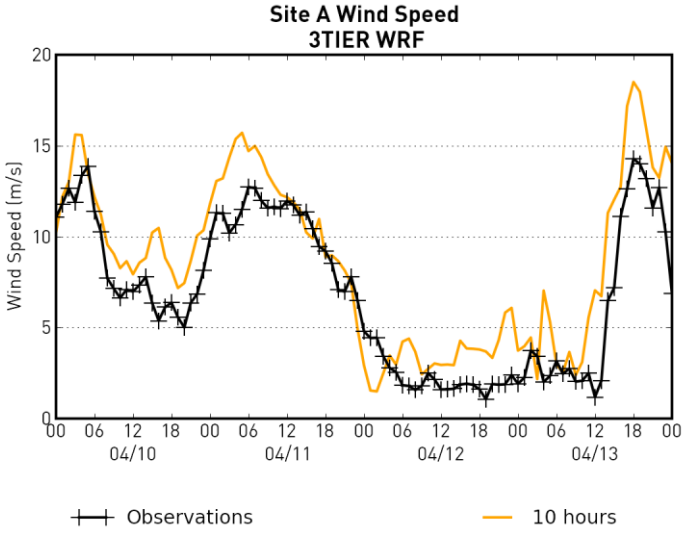
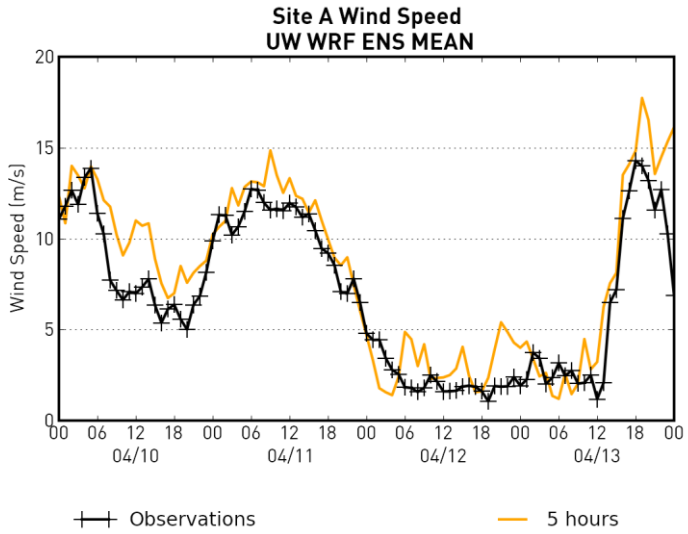
Wind Power Re-Forecasts

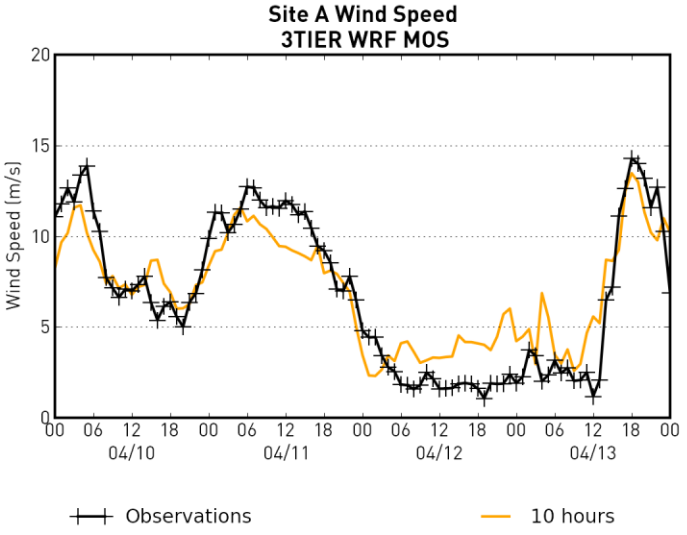
- Forecast Locations: 3 representative sites
  - Sites A and B in the Columbia Gorge, Site C in central MT
- Forecast Target: 1-hour lead, 1-hour interval

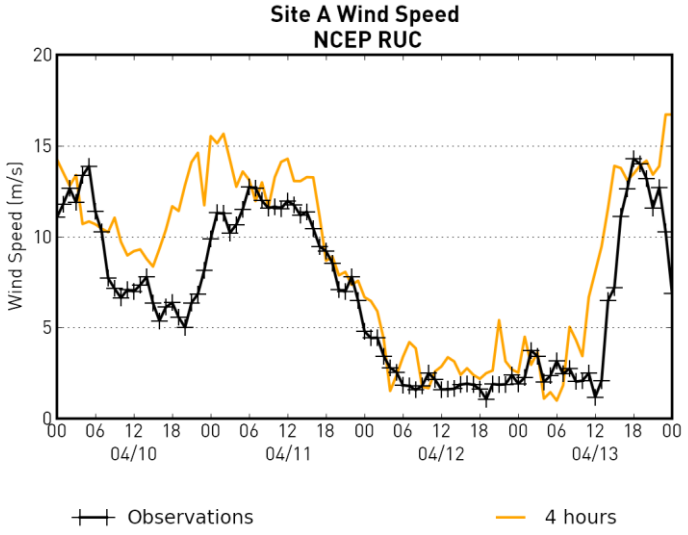
Forecast Name	Cycles	(Assumed) Delay	Relevant Forecast Horizons
UW WRF ENS MEAN	00, 03, 06, 09, 12, 15, 18, 21	(02:30)	F05, F06, F07
3TIER WRF (control)	00, 06, 12, 18	07:30	F10, F11, …, F15
3TIER WRF + MOS	00, 06, 12, 18	07:30	F10, F11, …, F15
NCEP RUC	00, 01, 02, 03, … 20, 21, 22, 23	01:45	F04

Site A :: Verification Time Series Comparison









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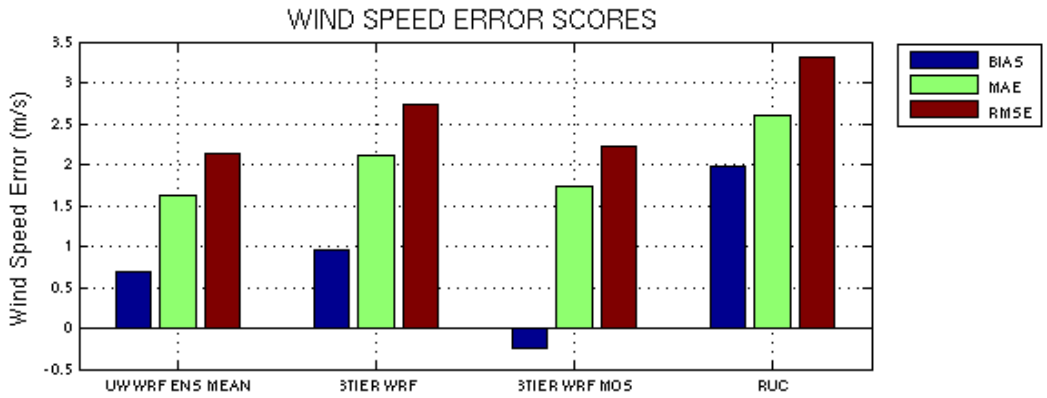
Site A :: Verification Summary Statistics

better



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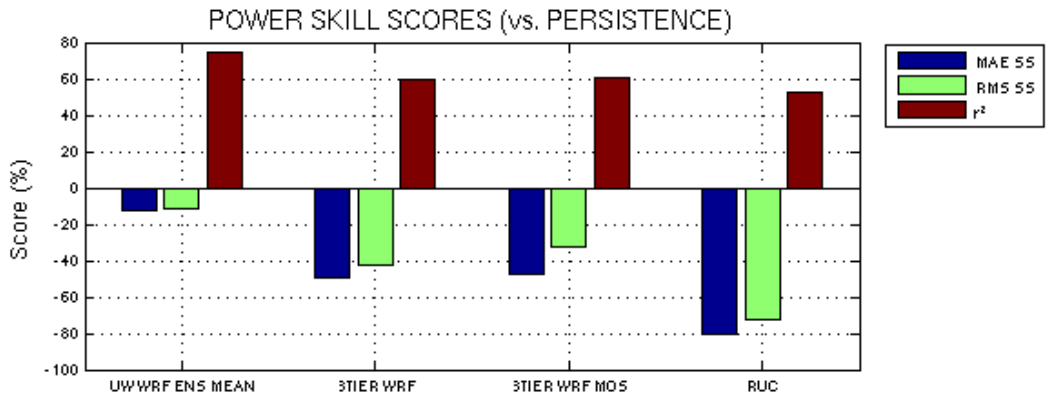

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Site B :: Verification Summary Statistics

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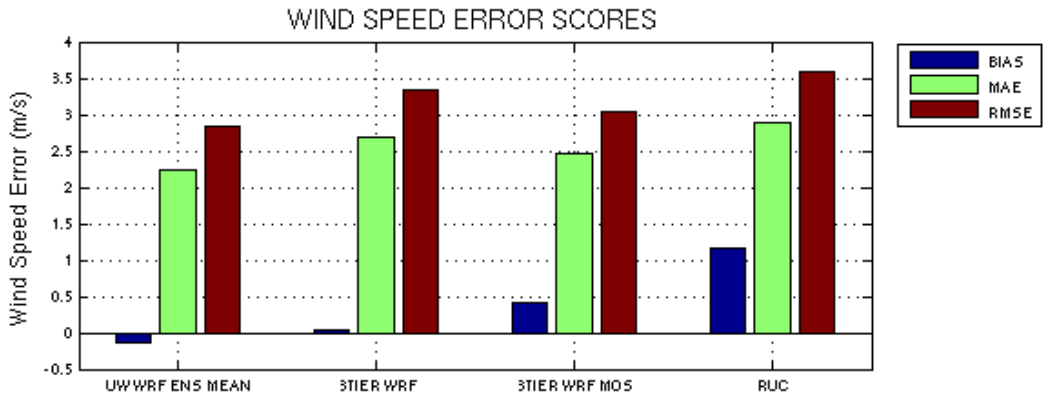

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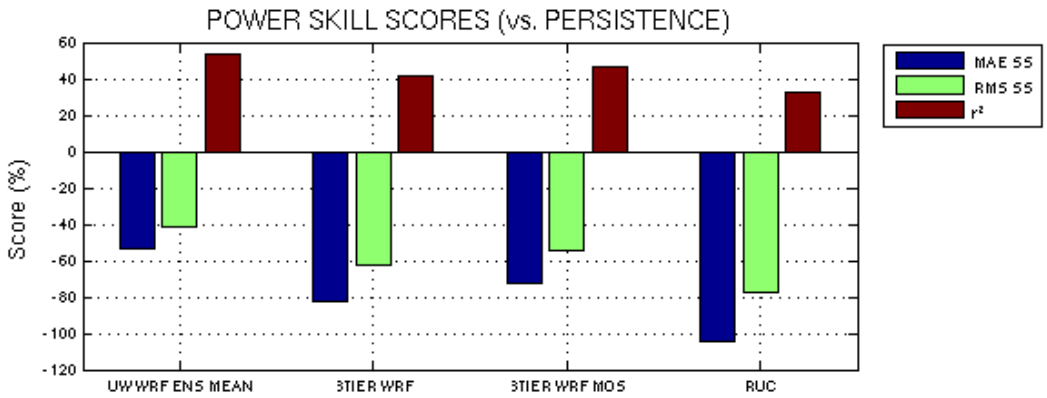

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Site C :: Verification Summary Statistics

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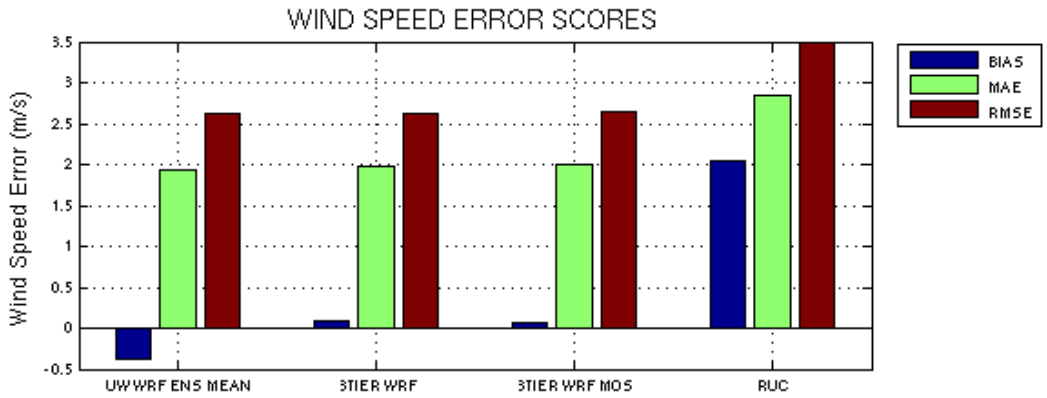

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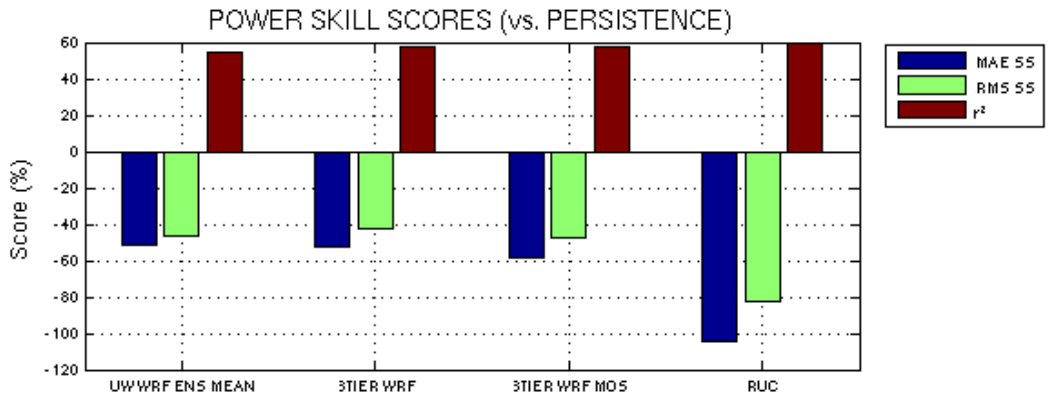

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Site A :: Ramp Event Detection Scores

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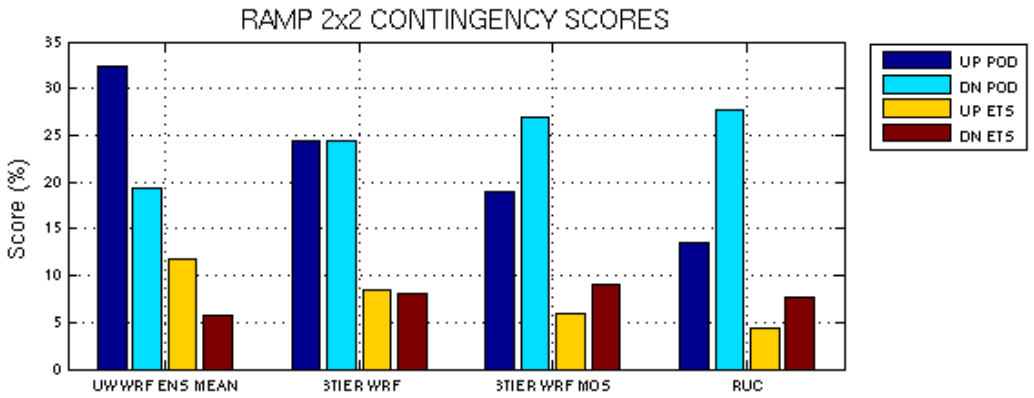

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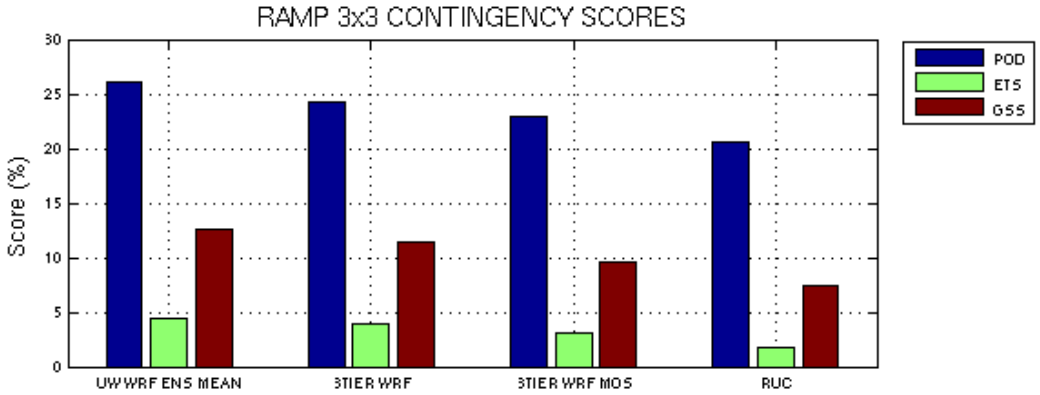

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Site B :: Ramp Event Detection Scores

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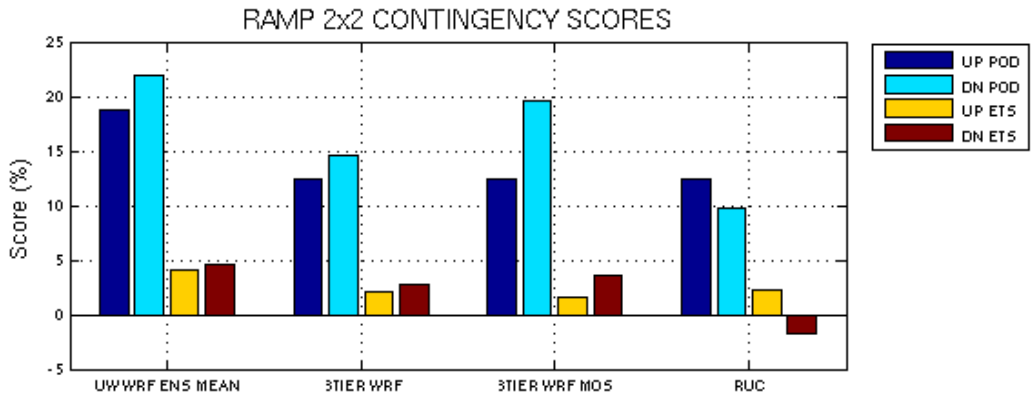

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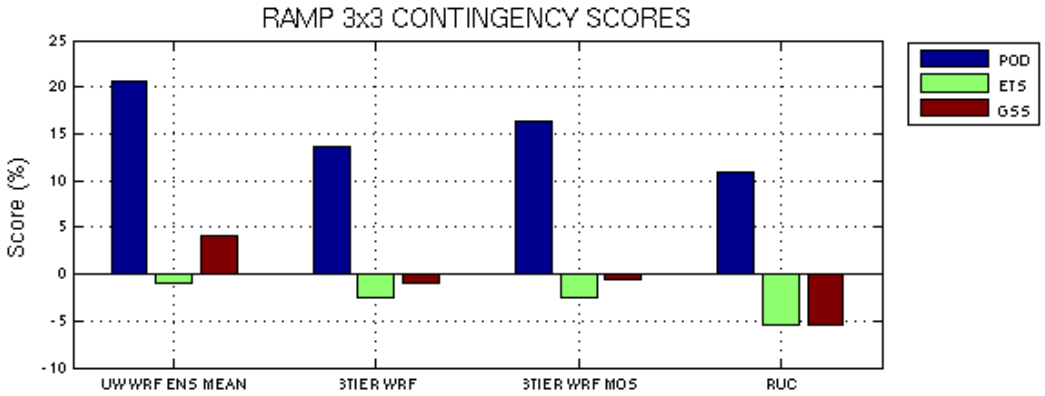

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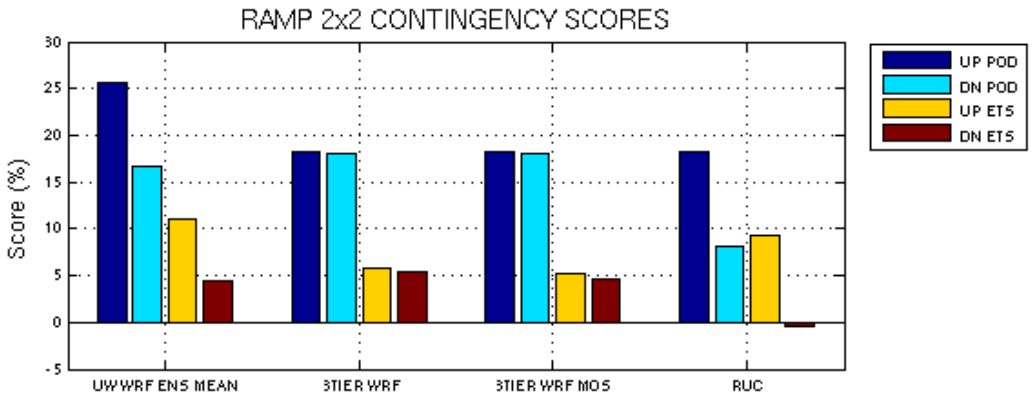

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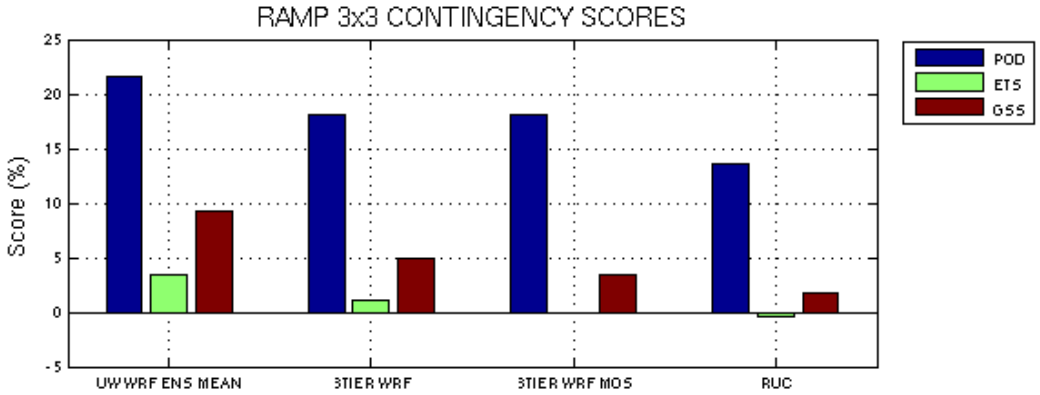

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Summary

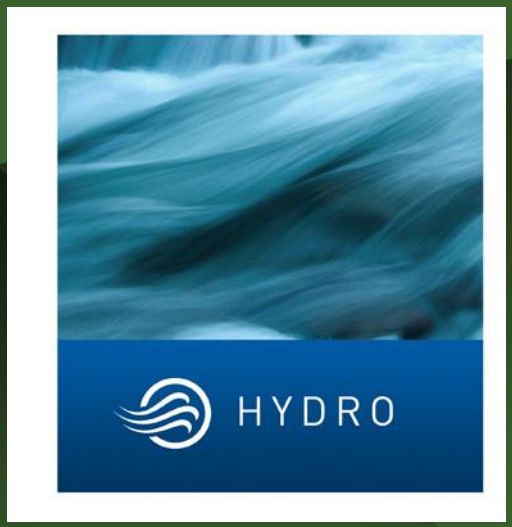
- UW WRF-EnKF system being tested at 3TIER for renewable energy forecasting applications, starting with wind power.

- Compared to running WRF using no data assimilation, the UW-3TIER ensemble mean forecast improves:
  - Timing and intensity errors associated with fronts more often than not
  - Mean absolute wind speed errors by 0.5 m/s at the 2 Columbia Gorge sites
  - Probability of up-ramp detection by 6-8% (ETS by 2-6%) at all 3 sites

- Using the NCEP RUC model as a benchmark forecast that employs data assimilation, the verification scores for the UW-3TIER ensemble mean are far superior.

Future Work

- Analyzing more aspects of the ensemble forecast quality
  - Verification scores achieved by the member closest to the mean
  - Probabilistic verification scores using the full 64-member ensemble
- Second test period (consulting with Matt Brewer)
  - Diurnally forced period with weaker synoptic-scale forcing
  - West coast thermal trough formation
  - Moderate to strong marine push
- Additional testing of new UW improvements
  - Assimilation of new observations and variables
  - Vertical localization
  - Bias correction



Thanks Also To:
Mark MacIver, Madge Dodson, and Lacey Holland
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